MOSS BAG EXPOSURE SURVEY IN THE VICINITY OF THE CPR CONCENTRATE TRANSHIPMENT FACILITY SCHREIBER, 1987-88

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INTRODUCTION

During the fall of 1987, CPR (CP Rail) constructed a concrete pad at a rail siding near a residential area in Schreiber. The pad was to receive zinc and copper concentrates from the Minnova Inc. base metal mine, 20 km (kilometres) northwest of Schreiber. Some local residents opposed the project because of concerns about possible health, environmental, noise and highway safety problems. Between January and August, 1988, concentrates from the mine were shipped by covered trucks to a temporary loading area (Figure 1). At this site, concentrate was dumped directly into rail cars. On August 18, 1988, the new permanent facility started to receive concentrates, hauled by truck from the mine by Trans Provincial Freight Carriers Limited.

The Ministry of the Environment conducted pre-operational vegetation sampling and moss bag exposure surveys near the transhipment site in the summer of 1987. A snow sampling survey was also carried out in the same area in February, 1988. Continuous wind direction and wind speed measurements began at the Schreiber Public School in October, 1988.

This report presents data from the 1987 pre-operational moss bag exposure survey and from the same survey repeated in 1988 after the transhipment site was placed in use.

METHODS

Mosses are effective in adsorbing and trapping certain kinds of airborne pollutants by a passive ion exchange process[1]. In Schreiber, bags of Sphagnum moss were exposed from July 14 to August 13, 1987 (pre-operational) and from August 31 to October 3, 1988 (operational). Each sample comprised about 4 g (grams) of oven-dried moss contained in a 10 by 20 cm (centimetre) envelope of polypropylene screening attached to a plastic supporting bracket about 1.5 to 3 m (metres) above the ground. After exposure, samples

were placed in paper bags and submitted to the Ministry's Thunder Bay laboratory. Samples were air-dried, then ground in a Wiley mill equipped with a 1-mm (millimetre) pore-size screen. Standard Ministry procedures were used to expose, collect and process the moss bags[2]. Samples were analyzed for arsenic, cadmium, copper, iron, lead, mercury, silver and zinc, all of which are present in the ore concentrates.

In 1987, moss was exposed at sites 1 to 10 (Figure 1). To improve the distribution of sampling points, five more sites were added in 1988 (sites 11, 17, 18, 19 and 20, Figure 1). Sites 1 and 7, used in 1987, were abandoned in 1988 due to construction of the transhipment facility. Moss bag control samples were also exposed at three sites remote from the survey area. One site was the Schreiber Sewage Treatment Plant, 1150 m southwest of the transhipment area. The other two sites were along the access road to the mine; the Lyne Lake control was about 9 km northwest of Schreiber and the Ambrose Lake control was 14 km north northwest. Unexposed moss was analyzed to determine background element levels.

Contaminant guidelines, developed by the Ministry for moss exposure studies, are used in this report. Their exceedence would suggest that contamination may be present but would not necessarily imply adverse effects.

RESULTS AND DISCUSSION

During the site visits on August 31 and October 3, 1988, puffs of visible particulate matter were seen in the air during the unloading of trucks and loading of rail cars at the transhipment site. Concentrates were being spilled on the asphalt apron in front of the concrete pad, and were also being spilled and carried on truck tires onto the gravel area between the pad and the railway cars. Tarpaulins to cover the concentrate were present on the site but did not appear to be in use.

Analysis results for copper and zinc concentrates are presented in Table 1. Zinc concentrate contained 53% zinc and copper concentrate contained 25% copper. Both concentrates contained significant amounts of other metals.

Table 2 shows the chemical analysis results from moss exposed in 1987 and 1988. In the 1987 pre-operational study, levels of all elements were low and were typical of normal background ranges expected in areas remote from pollution sources. Ministry guidelines were not exceeded.

In 1988, moss bag envelopes at sites 2, 4 and 17 (closest to the transhipment area) were covered by a gray-coloured particulate matter. Table 2 shows that significantly elevated concentrations of airborne cadmium, copper, iron and zinc occurred around the transhipment facility. Contaminant guidelines for cadmium, copper and zinc were exceeded on and off company property. Iron exceeded the guideline on railway property. Arsenic, lead, mercury and silver were slightly to moderately elevated. Arsenic was slightly above the guideline at three sites on company property; lead and mercury met the guidelines at all sampling points. A guideline for silver has not yet been established. Distribution patterns for all elements analyzed were similar to those shown in Figure 2 for zinc. Metal levels were highest near the transhipment site and decreased rapidly as distance from this point increased. Levels of all elements except mercury were much higher in 1988 than in 1987.

Table 2 shows that cadmium, copper, iron and zinc were higher in some of the 1988 controls than in the 1987 controls. While part of this difference may have been due to natural variation, we believe that it could be partly attributed to dust from ore handling and transportation. Contaminant effects were most obvious at the Schreiber sewage treatment plant, 1,150 metres southwest of the transhipment site. Lesser impact was found at the Lyne Lake control, 30 metres from the gravel road along which ore concentrate

is hauled from the mine. The Ambrose Lake control site, 150 metres from the same road, seemed fairly well protected from concentrate dust.

Table 3 shows the relationship between levels of elements in moss samples and distance to the centre of the concrete pad. As expected, there were no significant correlations in 1987. In 1988, however, strong negative relationships existed between all elements and distance from the transhipment area. These relationships implicate the transhipment area as the emission source.

CONCLUSIONS AND DISCUSSION

The 1988 survey near the CPR concentrate transhipment area in Schreiber showed that concentrations of copper and zinc significantly exceeded Ministry guidelines in exposed moss off company property. Off-property levels of cadmium were slightly above the guideline. Arsenic, lead and silver were elevated but met applicable guidelines off railway property. Levels of all elements, except mercury, were higher in 1988 than in 1987. The largest difference between years occurred for copper and zinc, where concentrations were hundreds of times higher in 1988 than in 1987. Sampling in 1988 was carried out less than two months after the new transhipment area was placed in service.

Our 1988 survey showed that there was significant fallout of ore concentrate dust off railway property in Schreiber. To determine if health-based air quality objectives are being exceeded, a sampling program with high volume samplers will soon commence at two residential sites. Apart from health concerns, however, the moss study clearly shows that there is potential contamination of off-property vegetation, soil and groundwater.

RECOMMENDATIONS

1. The Ministry, CP Rail and Trans Provincial should discuss a program of corrective measures to significantly reduce emissions of concentrate dust at the Schreiber transhipment facility.

2. An environmental monitoring program should continue. This program should include vegetation, soil and snow sampling, plus direct air sampling (hi-vol survey) and wind measurements. Groundwater assessment may also be appropriate.

REFERENCES

1. Temple, P. J., D. L. McLaughlin, S. N. Linzon and R. Wills. Moss bags as monitors of atmospheric deposition. Air Pollution Control Association. Volume 31, No 6. June 1981.

2. Ontario Ministry of the Environment. 1983. Field investigation procedures manual. Phytotoxicology Section, Air Resources Branch.

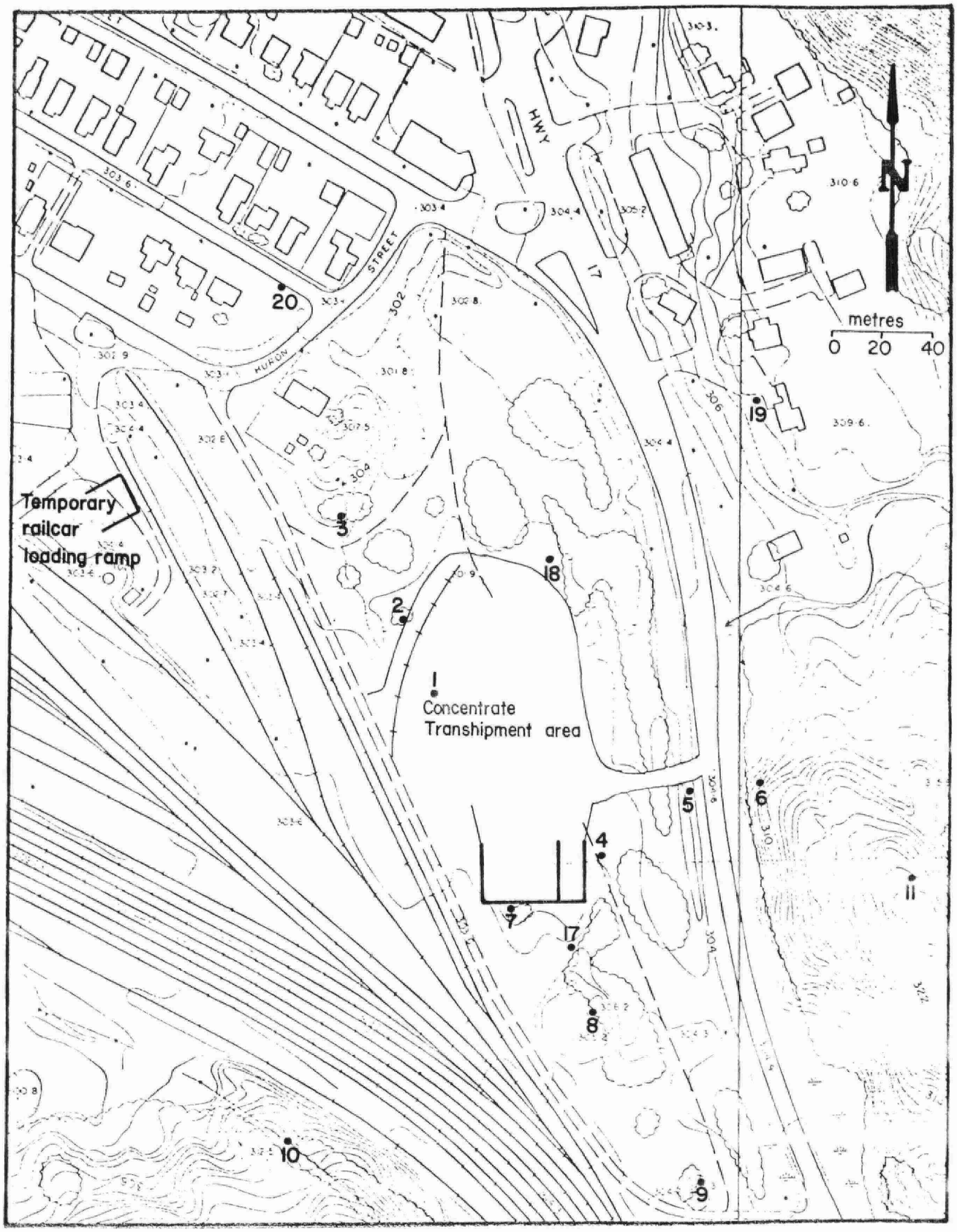

Figure 1. Moss bag exposure sites, Schreiber, 1987 and 1988.

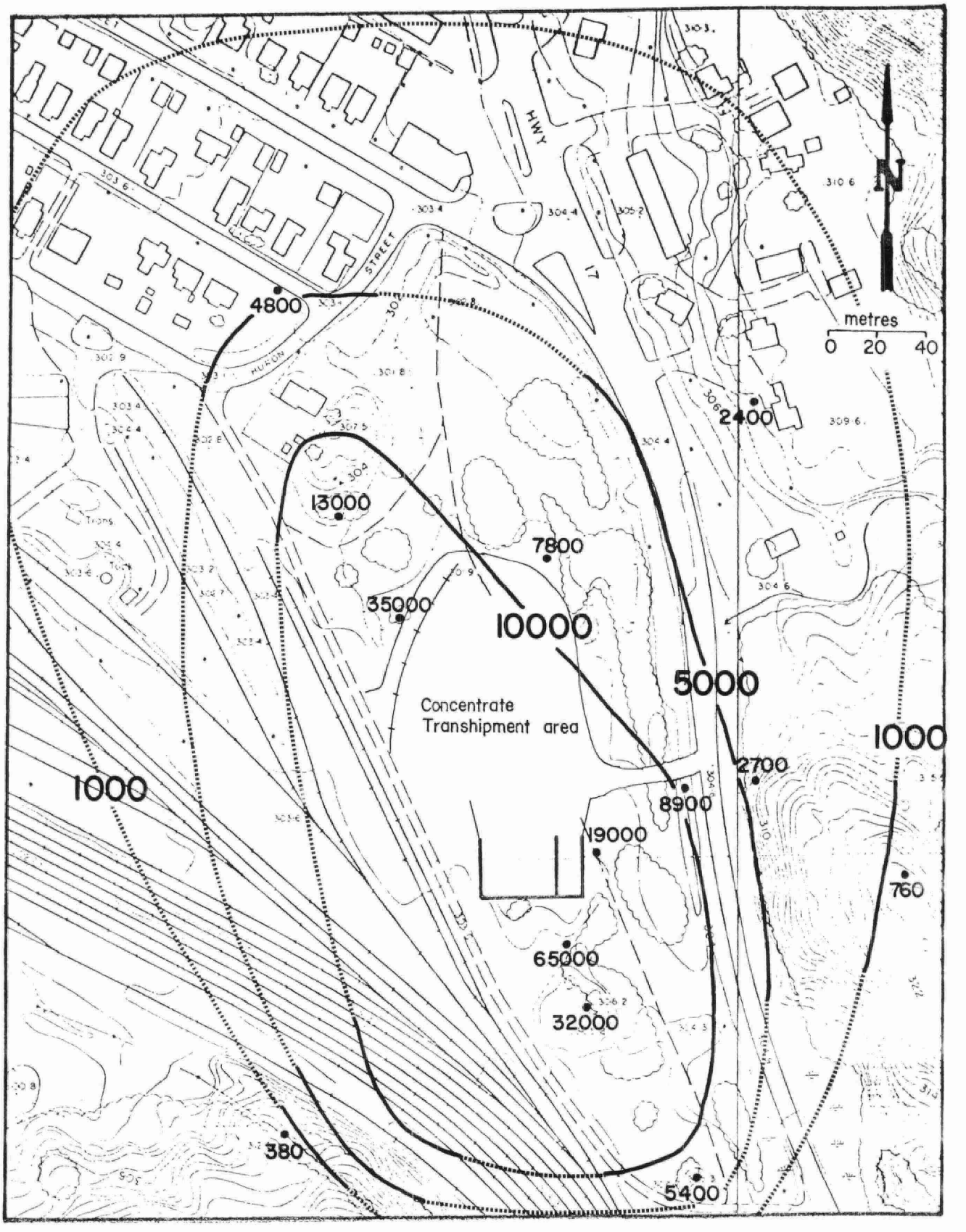

Figure 2. Levels of zinc (µg/g, dry weight) in exposed moss, Schreiber, 1988.

TABLE 1. Levels of selected elements (μg/g, dry weight) in zinc and copper concentrates from the Minnova Inc. mine, Schreiber, 1988[a].

Element	Zinc concentrate	Copper concentrate
Arsenic	20	110
Cadmium	1200	180
Copper	5500	250000
Iron	120000	290000
Lead	90	740
Mercury	5	3
Silver	40	340
Zinc	530000	75000

[a] Data supplied by Minnova Inc.

TABLE 2. Comparison between levels of selected elements (μg/g, dry weight) in moss exposed near the CPR concentrate transhipment area, Schreiber, 1987 and 1988.

	Arsenic		Cadmium		Copper		Iron		Lead		Mercury		Silver		Zinc	
Site[a]	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988
2	0.3	2.1[d]	0.4	80.0	4	2000	870	11000	6	32	0.08	0.15	<0.5	5.0	35	35000
3	0.4	1.2	0.5	30.0	5	680	1100	4500	7	23	0.11	0.14	<0.5	2.5	43	13000
4	0.3	2.5	0.4	44.0	4	3400	790	7800	6	42	0.09	0.17	<0.5	8.0	30	19000
5	0.3	0.8	0.4	20.0	4	990	820	990	7	27	0.08	0.11	<0.5	1.5	38	8900
6[b]	0.2	0.3	0.3	4.9	3	290	930	1700	5	7	0.10	0.09	<0.5	0.6	45	2700
7	0.3		0.4		5		1200		8		0.10		<0.5		34	
8	0.2	1.0	0.4	71.0	4	1600	610	8300	5	23	0.09	0.14	<0.5	3.0	33	32000
9	0.3	0.6	0.2	10.0	4	550	850	2300	5	12	0.09	0.12	<0.5	1.6	33	5400
10	0.4	0.4	0.3	<0.2	11	16	1000	920	5	6	0.10	0.09	<0.5	<0.5	220	380
11[b]		0.2		0.7		67		910		20		0.08		0.5		760
17		2.9		150.0		3800		17000		44		0.29		11.0		65000
18		0.8		18.0		1200		3900		20		0.13		3.0		7800
19[b]		0.7		4.3		250		1800		12		0.09		0.7		2400
20[b]		0.4		9.4		330		2700		15		0.11		0.6		4800
Exposed Controls:																
STP[c]	0.3	0.2	<0.2	0.6	2	13	700	1200	4	6	0.09	0.10	<0.5	<0.5	29	250
Ambrose Lk.	0.2	0.2	0.3	0.2	3	5	680	930	5	6	0.09	0.08	<0.5	<0.5	33	60
Lyne Lk.	0.2	0.1	0.3	0.2	3	8	630	1400	5	5	0.06	0.08	<0.5	<0.5	35	150
Unexposed controls	0.2	0.1	<0.2	0.2	3	2	940	860	6	4	0.09	0.09	<0.5	<0.5	32	52
Guidelines	2.0		4		60		3000		200		[e]		[e]		800	

[a] No data for site 1, which disappeared during construction of transhipment area.
[b] Sites off CP Rail property.
[c] Schreiber sewage treatment plant.
[d] Values exceeding Ministry of the Environment contaminant guidelines are underlined.
[e] Guidelines not established.

TABLE 3. Correlation between levels of metals in exposed moss and distance from the CPR concentrate transhipment area, Schreiber, 1987 and 1988.

Element	1987	1988
Arsenic	0.50	-0.62*
Cadmium	-0.24	-0.64*
Copper	0.37	-0.73*
Iron	0.15	-0.61*
Lead	-0.40	-0.64*
Mercury	0.30	-0.55*
Silver	0.00	-0.65*
Zinc	0.42	-0.64*

*Denotes a significant Pearson correlation at P <0.05